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J. R.

ECOLOGICAL PARAMETERS OF FOURWING SALTBUSH IN RELATIONSHIP TO MINE SPOIL RECLAMATION

ECOLOGICAL PARAMETERS OF FOURWING SALTBUSH IN RELATIONSHIP TO MINE SPOIL RECLAMATION

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James R. Moseley

and

Loren D. Potter

Biology Department

The University of New Mexico

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ABSTRACT

Laboratory and field studies were initiated to evaluate certain ecological parameters of fourwing saltbush (Atriplex canescens) in relationship to mine spoil reclamation. The field research was conducted at the Navajo Mine which is located southwest of Fruitland, New Mexico.

The ecological parameters which were clarified included: physical and chemical spoil characteristics on which fourwing saltbush was growing; growth characteristics and elemental concentrations of fourwing saltbush; and the response of fourwing saltbush to exposure and competition from Russian thistle (Salsola kali).

The concluded research indicates the revegetation potential of fourwing saltbush on heterogeneous spoil material. Elemental analyses elucidated high biomagnification potentials but the lack of toxic elemental accumulations in fourwing saltbush. Although growth indices (height times foliage diameter) for fourwing saltbush were decreased by competition from Russian thistle, this competition had a more profound effect on seeded grass species.

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INTRODUCTION

Most of the reclamation methodology and research in the United States does not involve the arid and semi-arid regions of the Southwest. As a result, the majority of the literature does not clarify or establish procedures to combat reclamation problems encountered in this geographical area.

Certain overviews of reclamation for the western states have been presented (Cook 1976 and Copeland 1973); but much of the research directly involving the Southwestern states has been initiated by the Albuquerque unit of the Rocky Mountain Forest and Range Experiment Station (Aldon 1970a, 1970b, 1973, 1975a, 1975b; Aldon and Springfield 1973; Aldon, Knipe, and Garcia 1973; Aldon, Springfield, and Garcia 1975). This unit, through cooperative agreements, has also funded research at the University of New Mexico which is closely related to our field research with fourwing saltbush [Atriplex canescens (Pursh.) Nutt.] (Deichmann and Potter 1978, Edgar 1977, and Hjelle 1977).

The research for this project was conducted at the Navajo Mine of Utah International Inc. The mine offices and Four Corners Power Plant are located 6 miles southwest of Fruitland, New Mexico. The mine is leased by Utah International Inc. from the Navajo Tribe and encompasses more than 31,416 acres. The lease lies in Townships 28 N and 29 N, R 15 W, and Townships 25, 26, 27, and 28 N, R 16 W. Average annual precipitation is only 6 to 8 inches while temperature ranges from -16° to 103° F.

A detailed existing mine description can be found in the final environmental statement of the Wesco gasification project (USDI 1976).

The purpose of this study was to evaluate certain ecological parameters of fourwing saltbush in relationship to mine spoil reclamation. The study had a three-year duration from 1975 through 1977. The 1975 study determined ranges of physical and chemical characteristics of certain spoils as well as growth and elemental parameters of fourwing saltbush growing on these spoils. During 1976 the following ecological aspects of fourwing saltbush were studied: elemental analyses of differently aged plants; response of fourwing saltbush to various slope exposures; effects of competition from Russian thistle (Salsola kali); and the response of seeded species to Russian thistle as a green mulch. Further evaluations of the exposure and competition plots for fourwing and the Russian thistle mulch study were completed during the 1977 field season. Study procedure and collected data for each of the three years will be presented.

Appreciation is expressed to Mr. Earl Aldon of the U.S. Forest Service for financial support (Cooperative Study Project No. 16-551-CA-SEAM). Mr. Sterling Grogan and his environmental staff of Utah International Inc. were very helpful in terms of time and equipment to set up this research. Finally, special thanks are extended to Paula Woodbridge who supervised the laboratory analyses.

DISCUSSION

1975 Study

Preliminary Study

Description. The 1975 study area was located in Navajo Mine designated plot C3-75 (C - Custer Pit). From earlier spoil analyses by mine personnel, an area was selected thought to be homogeneous in terms of physical and chemical spoil characteristics.

Four 20 X 20 meter subplots on each of four exposures (west, crest, east, and valley) were randomly sampled for plant and spoil data. Twelve composited spoil samples from each of the four exposures were physically and chemically analyzed. Those data are presented in Tables 1-8.

From the same random sites used for spoil collection, samples of fourwing saltbush twigs and leaves were composited and elementally analyzed. Tables 9-12 contain these data. Heights and diameters for three fourwing saltbush plants nearest the twelve random sites in each exposure were recorded. A growth index for each plant was derived by multiplying height times foliage diameter. The mean values of growth indices for the three plants from each random site are presented in Table 13.

Results. Mean growth indices for fourwing saltbush in decreasing order were: East - 431.33; Valley - 385.42; Crest - 332.08; and West - 210.83. Analysis of variance of the growth indices indicated a highly significant difference ($p < 0.01$) for fourwing saltbush on the four exposures. Correlations

between corresponding elemental levels in fourwing tissue samples and spoils were evaluated. Highly significant ($p < 0.01$) positive correlations were found for calcium, sodium, and chlorine while similar ($p < 0.01$) negative correlations were found for cadmium and chromium. Correlations between spoil elemental levels and fourwing saltbush growth indices were also determined. Significant ($p < 0.05$) negative correlations were found for the following elements: calcium, magnesium, sodium, manganese, copper, and mercury. Sodium adsorption ratio and exchangeable sodium percentage also gave significant ($p < 0.05$) negative correlations. The mean elemental values of the four exposures for spoil and fourwing saltbush are contained in Table 14; the biomagnification factors for each element are also presented.

1976 Studies

Four studies further clarifying ecological aspects of fourwing saltbush were initiated during the summer of 1976:

a. elemental analyses of differently aged saltbush plants;
b. response of saltbush to different exposures;
c. effects on saltbush from competition with Russian thistle;
d. response of seeded species to Russian thistle as a green mulch.

Elemental Analyses of Differently Aged Saltbush Plants

Description. After reviewing the 1975 elemental analyses and corresponding biomagnification factors, it was decided to analyze elemental levels of differently aged saltbush plants.

By using different revegetation areas, elemental levels in plants up to five years of age could be determined. Mature native saltbush plants on unmined soil were also sampled and compared to younger plants growing on spoil material. Four composited samples, each from 15 plants, from 1972 through 1976 were analyzed in the laboratory. Four composited samples from native plants were analyzed in a similar manner. The sampled locations adhere to mine designated revegetation areas. The five-year-old saltbush plants came from the four 1972 experimental plots. The site numbers correspond to the experimental plot numbers in Table 15. The four-year-old plants were collected from the Watson Triangle. Various spoil amendments were used in these 1973 revegetation plots. From Table 15, site 73-1 had gypsum as an amendment; 73-2, gypsum and bottom ash; 73-3, top soil; and 73-4 had no amendment. The three-year-old plants were collected on the drip and sprinkler revegetation area of the Bighan Pit. Plants collected on sites 74-1 and 74-2 (Table 15) were on mine designated plot BH2-74 and under drip irrigation. The remaining three-year-old plants on sites 74-3 and 74-4 were collected on plot BH1-74 and under sprinkler irrigation. Mine plot DB2-75 (Doby Pit) contained sampled plants, sites 75-1 and 75-2 (Table 15). Site 75-1 had no bottom ash as an amendment while site 75-2 had been amended with bottom ash. Site 75-3 (Table 15) had plants collected on plot DB5-75 while the final two-year-old plants for site 75-4 were sampled on mine plot C3-75 (Custer Pit). The plants which had completed one growing season were harvested from plots used

in the Russian thistle competition study on mine plot DB3-76. Sites 76-1 through 4 correspond to valley, east, crest, and west, respectively. Finally, native plants of an undetermined age were collected from a wash southwest of mine plot DB4-76.

Results. The results of the elemental analyses for the differently aged saltbush plants are presented in Table 15. Analyses of variance were run for each of the analyzed elements. Highly significant differences ($p < 0.01$) were found for all elements except selenium. Mean contrasts were made by grouping all plants on spoil material as opposed to native plants. Significant contrasts were found for calcium, copper, and manganese.

Response of Saltbush to Different Exposures

Description. The 1976 exposure study was located on the DB3-76 (Doby Pit) reclamation area. Sixteen 25 m^2 subplots on four exposures (west, crest, east, and valley) were randomly sampled to clarify the response of saltbush to exposure. Spoil samples were composited within each of the subplots and analyzed in the laboratory. These physical and chemical spoil data are presented in Tables 16 and 17. At the end of the 1976 growing season, density of saltbush in each of the sixteen subplots was determined. Table 18 contains the density data.

Results. Analyses of variance indicated no significant differences due to exposure in any of the physical or chemical spoil parameters. There was a significant difference ($p < 0.05$) in saltbush numbers for the four different exposures. The mean plant numbers are found in Table 18.

Effects on Saltbush from Competition with Russian Thistle

Description. To assess competitive effects, Russian thistle seedlings were removed by hand from five plots on the west side of 76 DB-3. Each plot consisted of 25 square meters. At the end of the 1976 growing season, density of saltbush, as well as height and diameter of each plant, were collected in the five plots. Similar data were collected in five randomly selected adjacent plots in which the Russian thistle had not been removed. In the five non-competition plots composited soil samples were collected for laboratory analyses.

Results. Physical and chemical parameters of spoil samples collected from the DB3-76 non-competition plots are found in Tables 19 and 20. In Table 21 are given the values for saltbush as to density of plants; height, diameter, and growth indices; and percentage of foliage cover after one and two years of growth.

Control of Russian Thistle

Description. After working with the immense stand of Russian thistle on mine plot DB3-76, methods to eliminate competition against seeded species were considered. One possible solution that was initiated involved the use of Russian thistle as a green mulch. During the first week of August of 1976 an area 100 X 450 ft, which had virtually 100 percent Russian thistle cover, was disced. Due to the density and coverage of Russian thistle, the study area had to be redisced several times. The area was then reseeded with the same seed mixture

that had been used earlier in the spring. The area was divided into three 30 X 450 ft treatment plots to test the effect of a sheepsfoot roller. The first plot was not rolled with the sheepsfoot. The second plot was rolled once, and the third plot was rolled with the sheepsfoot three times. A solid set irrigation system was then installed on the plots and the area received less than 3.5 inches of water during August and September 1976. The area was randomly sampled for plant density and percentage foliage cover during the first week of November of 1976 and 1977. An adjacent area outside the plots served as a comparison in which the Russian thistle was not disced under. The values for plant density and coverage are presented in Tables 22, 23, 24, and 25.

Results. Analyses of variance were used for comparisons of the four treatments: no treatment (the undisced areas outside the plot); disced, reseeded, but not sheepsfoot; disced, reseeded, and once over with a sheepsfoot; and disced, reseeded, and three times over with a sheepsfoot. After the 1977 growing season, significant differences ($p < 0.05$) of saltbush cover were found between the treated and untreated areas. No significant differences were found among the treatments. Similar comparisons for the cover of reseeded grasses indicated a highly significant difference ($p < 0.001$) between the treated and untreated areas but again no significant difference was found among treatments.

CONCLUSIONS

Physical and Chemical Spoil Characteristics

The ranges of the spoil physical and chemical characteristics are indicative of the heterogeneity of substrates available for plant establishment. The fact that fourwing saltbush can be established on spoil substrates with such a wide range of characteristics indicates the plasticity and reclamation potential of this species.

Elemental Analyses of Fourwing Saltbush

One of the basic purposes of the funding for this research was to establish elemental ranges for fourwing saltbush growing on spoil and unmined substrates. Results from the 1975 and 1976 studies provide these elemental ranges. Table 14 from the 1975 study presents the wide range in biomagnification factors. The only toxic element that could potentially present revegetation problems is selenium. The only high selenium level (7.03 ppm) was found on the first 1972 experimental plot. This plot overlies fly ash (Grogan, S. 1976 person. commun.) and indicates the potential selenium-accumulating ability of fourwing saltbush.

The large ranges for the coefficients of variation for elemental analyses from differently aged plants indicate no problems in plants growing on spoil and unmined substrates. Although significant contrasts for calcium, copper, and manganese were found between native and spoil-grown plants, potential biomagnification problems should not occur.

Saltbush Response to Exposure

The growth indices for saltbush grown in the 1975 study show best growth on east-facing and valley exposures and least growth on a west-facing exposure. Similar findings did not occur in the 1976 study. Two factors probably affected these dissimilar outcomes: firstly, the competition from Russian thistle probably played a more important role than exposure, and secondly, differential irrigation occurred on plot DB3-76. Since water is the primary limiting factor in this arid environment, the differential irrigation should override the relatively gentle exposure changes found at Navajo Mine.

Saltbush Competition with Russian Thistle

From Table 21, it is found that after the second growing season (1977) the saltbush coverage values are almost five times greater in the non-competition plots. The mean growth indices are 3.5 times greater in the noncompetition plots. As would be expected without competition, the saltbush plants had about equal height and diameter values (for 1977, means of 43.7 and 41.8, respectively). With competition from Russian thistle, the saltbush plants were not as tall and had a significantly smaller diameter.

Control of Russian Thistle by Its Use as a Green Mulch

Probably the most significant point of this study was the elimination of competition from Russian thistle. The increased substrate nitrogen level could be very important

but its significance against competitive elimination can not be identified in this study. No significant differences were found in terms of coverage of either saltbush or reseeded grasses among the sheepsfoot treatments. The savings by not requiring any sheepsfoot treatment is financially important and should not significantly affect plant cover for this type substrate. Although increases of saltbush cover were found after the second growing season in the disced versus the undisced areas, the increase in grass cover was most important. Without the elimination of Russian thistle and subsequent reseeding, no grasses were found in the undisced areas.

Future Research

From observations of fourwing saltbush at Navajo Mine, it is apparent that it has great reclamation potential. The basic germination and establishment procedures have been elucidated by Springfield (1970) and Cable (1972). The morphological adaptation of root development in different substrates as well as with and without competitive factors are important areas of research in terms of reclamation potential. From the competition studies, the control of Russian thistle is another important research area. The economic feasibility of using Russian thistle as a green mulch is probably questionable on large areas. A late irrigation schedule would considerably reduce competition from Russian thistle while not significantly affecting shrub and grass cover. Perhaps very early irrigation and fire could

also be used in the control of Russian thistle. It is obvious that much more research is needed in the field aspects of revegetation with fourwing saltbush.

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APPENDIX

Methods

Sample Collection

1. Spoil

Spoil samples were collected from within the rooting zones of saltbush plants. In most cases samples were composited and this is clarified in the description of each study.

2. Plant

Potentially browsed portions (twigs and leaves) of saltbush plants were clipped and composited into single samples.

Analytical Procedures

1. Spoil

a. Spoil particle size analyses.

The hydrometer method developed by Bouyoucos (1936) was used in spoil particle size analyses.

b. pH and electrical conductivity.

These analyses were conducted according to procedures for a saturated paste as presented by the U.S. Salinity Laboratory (USDA 1954).

c. Sodium adsorption ratio and exchangeable sodium percentage.

These data are developed according to equations outlined by the U. S. Salinity Laboratory (USDA 1954).

d. Cation extraction and cation exchange capacity.

This method was based on Black (1965) and the procedure used follows.

Place 5.000 grams of oven-dried soil into 50 ml centrifuge tubes (tubes should have screw caps). Extract 8 times with 27 ml portion of 1.0 N ammonium acetate (pH of ammonium acetate should be adjusted to 5.2 with glacial acetic acid to achieve greater extraction of carbonate salts). Each extraction should be performed as follows:

1. add 25 ml of extraction solution to soil in centrifuge tube;
2. hand shake soil and solution for 5 min;
3. let soil and solution lie on side for 10 min to achieve more complete extraction;
4. centrifuge for 5 min to settle out clay fraction;
5. decant off extraction solution into rinsed suction filter with a Whatman #42 filter paper;
6. repeat above steps seven more times and after eighth extraction, filter through rinsed funnel with Whatman #42 filter paper into a 250 ml volumetric flask;
7. rinse out suction flask 3 times with extraction solution and rinse funnel as often as possible;
8. bring solution up to volume and transfer to 500 ml linear polyethylene bottles for storage prior to cation analysis.

This extraction should remove about 99% of the total soluble and exchangeable salts. The last extraction should contain less than 1% of the total amount and early tests have shown that the eighth extraction did contain less than 1% of the total amount of Ca and Na. The extracted soil is then leached four times with a neutral pH 1 N NH_4Cl solution and then once with 0.25 N NH_4Cl. Rinse soils then with 200 ml of isopropyl alcohol to remove all electrolytes. Finally, each soil should be leached with 8 separate extractions with 27 ml of 10% NaCl acidified with HCl to obtain .005 N HCl using the same extraction method used for ammonium acetate solution without the 15 min of setting before centrifuging. Make final volume of NaCl up to 250 ml and analyze this solution for ammonium to determine Cation Exchange Capacity. Express all final C.E.C. measurements as C.E.C./100 grams soil.

The ammonium acetate extraction is used for the following analyses: major cations (calcium, magnesium, sodium, potassium), all heavy metals except mercury. Analysis of all cations and metals are done on a Perkin-Elmer Atomic Absorption Spectrophotometer Model 306 with a HGA 2100 graphite furnace. Major cations are performed with standard conditions set in the Handbook by Perkin-Elmer using air-acetylene flame. All metals are run on the flame where levels are high enough, and on the HGA 2100 for low levels. The HGA 2100 standard conditions are used for metal analyses using the non-interrupt mode. Optimum atomization temperatures are determined for each element and % recoveries are performed, and when % recoveries are not in the 90-110% range, the samples are analyzed by standard additions methods.

Arsenic and selenium are run on a hydride generator attachment for the Atomic Absorption Spectrophotometer.

Mercury concentrations are determined with E.P.A. procedure of sulfuric acid-hydrogen peroxide digestion followed by Atomic Absorption Analysis. (E.P.A., 1974)

e. Anion analyses.

Analyses for nitrate, nitrite, and chloride follow the standard procedures of Technicon Industrial Systems, Technical Publ. No. TJ1-0268, Technicon Autoanalyzer II Industrial System. Industrial Method No. 99-70W (1974) is used for the analyses of chloride. Industrial Method No. 100-70W (1973) is used for the analyses of nitrate and nitrite.

2. Plant digestion (HNO_3-HCL method)

Plants are ground to less than 40 mesh in a Wiley mill. Ten grams of ground, dried plant tissue are accurately weighed into a Technicon BD digestion tube to the nearest 0.1 milligram. To the tissue is added 10 ml of concentrated nitric acid. The samples are allowed to stand until the foaming subsides (usually 1-2 hours, preferably over night). Add 10 ml of concentrated hydrochloric acid. Again allow the samples to stand until the foaming subsides. The samples are then boiled on a block digestor at 150° C until half the original volume remains (1-2 hours). The samples are then cooled and filtered through Whatman 22 filters into 100 ml volumetric flasks (the filters should be rinsed with 6N HCl before the samples are filtered). The flasks are brought up to volume and appropriate dilutions made to analyze by atomic absorption spectrophotometry.

3. Statistical

Statistical procedures followed those of Sokal and Rohlf (1969).

Table 1. Elemental analyses of spoil, Custer Pit, Plot 3, 1975 seeding, west exposure

Sample Percentage (dry weight)

	Ca	Mg	Na	K	Fe	Mn	Zn*	Cu*	Cd*	Pb*	Co*	Cr*	Ni*	As*	Hg*	Se*	NO_3^{-}* NO_2^{-}	Cl^{-}
	2.36	0.112	0.126	0.0199	0.0132	0.0415	1.70	0.60						0.04	<0.005	0.04	0.55	0.0176
	2.15	0.123	0.120	0.0221	0.0065	0.0283	1.10	1.10						0.15	0.015	0.05	0.50	0.0138
	2.29	0.109	0.099	0.0194	0.0087	0.0344	1.15	0.60	0.100	2.51	0.490	0.075	1.085	0.02	<0.005	0.04	0.50	0.0090
	2.04	0.116	0.120	0.0209	0.0077	0.0312	1.20	0.65						0.06	0.010	0.015	1.45	0.0093
	2.06	0.104	0.085	0.0377	0.0078	0.0308	0.85	1.00						0.09	0.005	0.005	0.30	0.0068
	2.34	0.112	0.133	0.0201	0.0095	0.0366	1.40	1.00						0.35	0.005	0.005	1.25	0.0115
	2.29	0.103	0.119	0.0182	0.0121	0.0401	1.60	0.75	0.080	2.54	0.575	0.080	0.390	0.005	0.005	0.005	0.50	0.0095
	1.91	0.104	0.115	0.0176	0.0061	0.0256	0.90	0.65						0.04	0.005	0.04	0.25	0.0099
	2.10	0.107	0.090	0.0191	0.0070	0.0299	3.24	0.85						0.18	<0.005	0.015	0.85	0.0070
	1.80	0.109	0.089	0.0187	0.0053	0.0249	1.60	0.70						0.12	<0.005	0.025	0.50	0.0059
	1.84	0.104	0.108	0.0180	0.0064	0.0272	2.85	0.65	0.096	2.37	0.530	0.060	0.390	<0.005	<0.005	0.015	0.40	0.0064
	2.31	0.107	0.081	0.0200	0.0099	0.0367	2.45	0.80						0.005	0.005	0.005	0.45	0.0072
$\bar{x}$	2.124	0.1092	0.1071	0.02098	0.00835	0.03227	1.670	0.779	0.0920	2.473	0.5317	0.0717	0.6217	0.0888	0.0063	0.0217	0.625	0.00949
sd	0.199	0.0059	0.0176	0.00542	0.00244	0.00555	0.776	0.172	0.0106	0.091	0.0425	0.0104	0.4013	0.1012	0.0031	0.0167	0.371	0.00344
CV	9.37	5.40	16.43	25.83	29.22	17.20	46.47	22.08	11.52	3.68	7.99	14.50	64.55	113.96	49.21	76.96	59.36	36.25

*Percentage X 10^{-4}

Table 2. Elemental analyses of spoil, Custer Pit, Plot 3, 1975 seeding, crest exposure

	Sample Percentage (dry weight)																	
	Ca	Mg	Na	K	Fe	Mn	Zn*	Cu*	Cd*	Pb*	Co*	Cr*	Ni*	As*	Hg*	Se*	NO_3^{-*} NO_2^-	Cl^-
	1.55	0.113	0.127	0.0195	0.0028	0.0162	1.40	0.45						0.10	0.005	0.015	3.10	0.0114
	1.94	0.108	0.121	0.0204	0.0091	0.0309	1.55	0.50						0.02	<0.005	0.025	0.55	0.0102
	1.81	0.106	0.117	0.0196	0.0046	0.0234	1.10	0.45	0.100	2.07	0.460	0.060	0.30	0.12	<0.005	0.03	1.45	0.0087
	1.62	0.101	0.075	0.0180	0.0050	0.0207	1.25	0.40						0.15	0.005	0.03	0.65	0.0084
	1.98	0.110	0.084	0.0204	0.0052	0.0218	2.10	0.25						0.04	<0.005	0.015	0.70	0.0074
	1.97	0.106	0.084	0.0203	0.0062	0.0239	1.60	0.45						0.12	<0.005	0.03	0.85	0.0076
	1.69	0.086	0.050	0.0115	0.0013	0.0089	0.75	0.30	0.100	1.85	0.490	0.030	0.275	0.10	0.005	0.06	0.40	0.0102
	1.28	0.084	0.067	0.0146	0.0032	0.0137	0.75	0.25						0.17	<0.005	0.015	0.90	0.0047
	1.48	0.091	0.075	0.0144	0.0032	0.0142	1.00	0.40						0.10	0.005	0.005	0.50	0.0067
	1.61	0.095	0.070	0.0183	0.0036	0.0169	1.75	0.15						0.21	0.005	0.015	0.85	0.0065
	1.24	0.086	0.051	0.0189	0.0018	0.0115	1.65	0.15	0.055	1.78	0.425	0.040	0.380	0.26	0.010	0.025	0.80	0.0100
	1.51	0.093	0.062	0.0199	0.0031	0.0162	1.85	0.45						0.29	0.005	0.04	1.15	0.0069
$\bar{x}$	1.640	0.0983	0.0819	0.01798	0.00409	0.01819	1.396	0.350	0.0850	1.900	0.458	0.0433	0.3183	0.140	0.0054	0.0254	0.992	0.00823
sd	0.250	0.0103	0.0263	0.00291	0.00212	0.00616	0.432	0.124	0.0260	0.151	0.033	0.0153	0.0548	0.081	0.0014	0.0145	0.723	0.00195
CV	15.24	10.48	32.11	16.18	51.83	33.86	30.95	35.43	30.59	7.95	7.21	35.33	17.22	57.86	25.93	57.09	72.88	23.69

*Percentage X 10^{-4}

Table 3. Elemental analyses of spoil, Custer Pit, Plot 3, 1975 seeding, east exposure

	Sample Percentage (dry weight)																	
	Ca	Mg	Na	K	Fe	Mn	Zn*	Cu*	Cd*	Pb*	Co*	Cr*	Ni*	As*	Hg*	Se*	NO_3^{-*} NO_2^-	Cl^-
	2.01	0.114	0.073	0.0275	0.0070	0.0262	1.35	0.55						0.17	0.005	0.025	0.85	0.0074
	2.39	0.117	0.090	0.0255	0.0106	0.0350	1.00	0.45						0.07	0.005	0.015	1.05	0.0076
	2.51	0.116	0.083	0.0216	0.0106	0.0335	1.30	0.70	0.075	2.80	0.710	0.070	0.465	0.02	0.005	<0.005	0.70	0.0096
	2.16	0.107	0.084	0.0210	0.0083	0.0268	1.50	0.50						0.04	<0.005	0.015	0.55	0.0082
	2.21	0.113	0.103	0.0216	0.0096	0.0299	1.80	0.60						0.07	0.005	0.025	0.90	0.0094
	1.82	0.103	0.072	0.0223	0.0057	0.0242	1.20	0.40						0.13	0.005	0.025	0.70	0.0075
	1.82	0.108	0.069	0.0215	0.0051	0.0241	1.80	0.35	0.070	2.14	0.475	0.065	0.30	0.10	0.005	0.015	1.10	0.0067
	1.69	0.100	0.075	0.0212	0.0049	0.0218	1.60	0.30						0.21	0.005	0.03	0.70	0.0129
	1.66	0.091	0.058	0.0161	0.0053	0.0213	1.25	0.40						0.10	0.005	0.015	0.60	0.005
	1.67	0.097	0.051	0.0202	0.0049	0.0202	1.60	0.20						0.18	0.005	0.025	0.75	0.0064
	1.64	0.099	0.050	0.0201	0.0040	0.0201	1.55	0.20	0.065	1.96	0.470	0.050	0.445	0.13	0.005	0.03	0.80	0.0067
	1.46	0.086	0.046	0.0152	0.0038	0.0147	1.35	0.20						0.18	0.005	0.025	0.60	0.0086
$\bar{x}$	1.920	0.1043	0.0712	0.02115	0.00665	0.02482	1.442	0.404	0.0700	2.300	0.5517	0.0617	0.4033	0.117	0.005	0.0208	0.775	0.00800
sd	0.332	0.0100	0.0175	0.00336	0.00251	0.00587	0.243	0.164	0.0050	0.442	0.1371	0.0104	0.0900	0.060	0.000	0.0076	0.174	0.00201
CV	17.29	9.59	24.58	15.89	37.74	23.65	16.85	40.59	7.14	19.22	24.85	16.86	22.32	51.28	0.000	36.54	22.45	25.13

*Percentage X 10^{-4}

Table 4. Elemental analyses of spoil, Custer Pit, Plot 3, 1975 seeding, valley exposure

Sample Percentage (dry weight)

	Ca	Mg	Na	K	Fe	Mn	Zn*	Cu*	Cd*	Pb*	Co*	Cr*	Ni*	As*	Hg*	Se*	NO_3^{-*} NO_2^-	Cl^-
	1.68	0.094	0.064	0.0215	0.0081	0.0230	1.70	0.50						0.15	<0.005	0.025	0.55	0.0069
	1.74	0.104	0.061	0.0202	0.0079	0.0236	1.55	0.40						0.15	0.010	0.05	1.40	0.0062
	1.80	0.114	0.059	0.0226	0.0092	0.0257	1.55	0.60	0.070	2.47	0.615	0.090	0.405	0.12	0.005	0.05	0.55	0.0058
	2.02	0.108	0.088	0.0208	0.0109	0.0288	1.55	0.35						0.13	0.005	0.025	0.55	0.0088
	2.18	0.107	0.087	0.0219	0.0134	0.0368	1.55	0.50						0.12	0.010	0.015	0.50	0.0094
	1.80	0.107	0.053	0.0203	0.0066	0.0218	1.05	0.30						0.05	0.010	0.015	0.40	0.0061
	1.62	0.098	0.056	0.0188	0.0061	0.0196	1.35	0.35	0.080	2.44	0.435	0.080	0.335	0.10	<0.005	0.03	0.45	0.0062
	1.67	0.103	0.078	0.0234	0.0061	0.0193	1.05	0.40						0.15	<0.005	0.015	1.95	0.0096
	1.91	0.097	0.058	0.0221	0.0057	0.0307	1.25	0.45						0.09	<0.005	0.015	0.70	0.0070
	1.81	0.098	0.064	0.0204	0.0120	0.0255	1.75	0.55						0.10	<0.005	0.015	0.55	0.0080
	1.48	0.093	0.054	0.0184	0.0027	0.0126	1.30	0.30	0.090	2.17	0.580	0.070	0.330	0.17	<0.005	0.005	0.70	0.0062
	1.27	0.080	0.046	0.0171	0.0042	0.0153	1.05	0.50						0.13	<0.005	0.005	0.50	0.0073
$\tilde{x}$	1.748	0.1003	0.0640	0.02063	0.00774	0.02356	1.392	0.433	0.0800	2.360	0.5433	0.0800	0.3567	0.122	0.0063	0.0221	0.733	0.00729
sd	0.238	0.0090	0.0134	0.00184	0.00318	0.00666	0.253	0.098	0.0100	0.165	0.0954	0.0100	0.0419	0.033	0.0023	0.0150	0.463	0.00135
CV	13.62	8.97	20.94	8.92	41.09	28.27	18.18	22.63	12.50	6.99	17.56	12.50	11.75	27.05	36.51	67.87	63.17	18.52

*Percentage X 10^{-4}

Table 5. Physical and chemical properties of spoil, Custer Pit, Plot 3, 1975 seeding, west exposure

	pH (sat. paste)	Electrical Conductivity E.C. 25 (mmhos/cm)	Sand (%)	Silt (%)	Clay (%)	Textural Classi-fication	Cation Exchange Capacity (meq/100g)	S.A.R.	E.S.P.	Saturation (%)
	7.79	3.63	39.8	18.4	41.8	C	20.36	11.33	13.38	48.3
	7.85	2.79	38.3	19.8	41.9	C	21.25	11.26	13.31	48.7
	7.76	2.00	40.0	20.4	39.6	CL	21.61	9.04	10.77	45.2
	7.79	2.22	37.5	20.9	41.6	C	22.93	11.56	13.64	47.9
	7.64	2.55	41.0	16.5	42.5	C	20.54	8.17	9.74	43.1
	7.75	4.41	41.3	18.2	40.5	C	22.04	12.01	14.13	48.0
	7.75	3.93	46.5	18.0	35.5	SaC	19.79	10.88	12.88	46.2
	7.82	4.24	45.2	18.2	36.6	SaC	19.29	11.46	13.53	43.3
	7.80	2.55	38.8	18.1	43.1	C	19.90	8.57	10.22	46.7
	7.51	2.39	39.0	17.6	43.4	C	21.60	9.11	10.86	44.8
	7.78	2.91	39.3	19.3	41.4	C	20.18	10.95	12.96	45.9
	7.66	2.26	41.3	19.7	39.0	CL	21.07	7.37	8.77	45.3
$\bar{x}$	7.742	2.990	40.67	18.76	40.58	CL	20.880	10.143	12.016	46.12
sd	0.095	0.841	2.70	1.27	2.49		1.059	1.579	1.819	1.88
CV	1.22	28.11	6.65	6.77	6.13		5.07	15.57	15.14	4.07

Table 6. Physical and chemical properties of spoil, Custer Pit, Plot 3, 1975 seeding, crest exposure

	pH (sat. paste)	Electrical Conductivity E.C. 25 (mmhos/cm)	Sand (%)	Silt (%)	Clay (%)	Textural Classification	Cation Exchange Capacity (meq/100g)	S.A.R.	E.S.P.	Saturation (%)
	7.38	7.43	40.2	17.9	41.9	C	21.79	13.93	16.17	48.4
	7.67	3.91	37.2	22.2	40.6	C	24.29	11.96	14.08	44.7
	7.58	6.09	43.6	19.3	37.1	CL	20.47	11.95	14.06	43.6
	7.39	4.69	45.5	17.6	36.9	SaC	19.54	8.09	9.64	41.2
	7.43	6.85	40.2	20.8	39.0	CL	22.61	8.22	9.80	44.9
	7.42	5.16	36.6	22.0	41.4	C	21.43	8.24	9.82	46.9
	7.59	3.97	62.6	10.5	26.9	SaCL	12.47	5.31	6.17	33.4
	7.29	4.09	52.9	13.0	34.1	SaCL	16.47	8.11	9.67	36.6
	7.37	6.45	53.5	15.8	30.7	SaCL	16.54	8.46	10.09	38.2
	7.05	5.65	48.2	13.7	38.1	SaC	20.11	7.58	9.03	41.8
	7.00	5.17	44.0	14.5	41.5	C	21.07	6.26	7.38	42.7
	7.02	5.10	45.1	16.5	38.4	SaC	20.72	6.93	8.22	40.5
$\bar{x}$	7.349	5.380	45.80	16.98	37.22	SaC	19.793	8.753	10.344	41.91
sd	0.224	1.150	7.55	3.69	4.61		3.208	2.551	2.950	4.31
CV	3.05	21.37	16.49	21.75	12.37		16.21	29.14	28.52	10.28

Table 7. Physical and chemical properties of spoil, Custer Pit, Plot 3, 1975 seeding, east exposure

	pH (sat. paste)	Electrical Conductivity E.C. 25 (mmhos/cm)	Sand (%)	Silt (%)	Clay (%)	Textural Classification	Cation Exchange Capacity (meq/100g)	S.A.R.	E.S.P.	Saturation (%)
	7.42	4.36	36.1	21.2	42.7	C	20.61	7.08	8.41	42.5
	7.56	3.59	35.2	19.9	44.9	C	21.79	8.04	9.58	42.9
	7.65	4.05	36.0	22.4	41.6	C	21.15	7.24	8.61	42.8
	7.24	5.49	37.1	22.3	40.6	C	20.93	7.89	9.40	42.9
	8.50	6.14	36.8	22.8	40.9	C	21.79	9.56	11.38	46.4
	8.40	4.57	40.1	22.8	37.1	CL	21.86	7.34	8.73	41.2
	8.39	4.49	39.1	20.7	40.2	C	21.86	7.03	8.35	44.0
	8.36	5.89	39.0	19.7	41.3	C	22.43	7.93	9.45	42.1
	8.32	3.75	52.6	11.5	35.9	SaC	21.79	6.20	7.31	38.1
	8.35	3.12	42.9	16.4	40.7	C	17.86	5.43	6.32	41.0
	8.18	4.11	42.1	15.6	42.3	C	21.61	5.36	6.23	43.1
	8.04	5.35	45.5	19.2	35.3	SaC	19.65	5.23	6.06	39.8
$\bar{x}$	8.034	4.576	40.21	19.50	40.29	C-CL	21.111	7.028	8.319	42.23
sd	0.444	0.950	5.01	3.42	2.84		1.261	1.293	1.600	2.09
CV	5.52	20.76	12.46	17.52	7.05		5.972	18.40	19.23	4.95

Table 8 Physical and chemical properties of spoil, Custer Pit, Plot 3, 1975 seeding, valley exposure

	pH (sat. paste)	Electrical Conductivity E.C. 25 (mmhos/cm)	Sand (%)	Silt (%)	Clay (%)	Textural Classification	Cation Exchange Capacity (meq/100g)	S.A.R.	E.S.P.	Saturation (%)
	8.03	5.09	41.5	18.4	40.1	C	19.93	6.80	8.06	40.6
	8.01	4.55	38.1	22.0	39.9	CL	21.18	6.35	7.50	42.2
	8.00	4.06	38.5	22.6	38.9	CL	21.93	6.03	7.09	42.2
	8.16	5.82	39.8	21.4	38.8	CL	21.50	8.53	10.17	44.3
	7.25	5.33	38.8	21.2	40.0	C	21.93	8.14	9.70	47.0
	7.48	2.69	42.1	18.6	39.3	CL	19.75	5.43	6.32	39.5
	7.40	3.60	39.3	27.9	32.8	CL	18.93	6.04	7.11	40.2
	7.28	5.68	44.2	19.0	36.8	CL	20.36	8.28	9.87	40.5
	7.43	3.31	41.8	17.1	41.1	C	20.07	5.79	6.79	40.5
	7.18	3.67	42.3	18.5	39.2	CL	20.75	6.39	7.55	42.7
	7.28	4.63	46.7	15.9	37.4	SaC	17.40	6.09	7.17	40.2
	7.32	4.03	48.9	14.1	37.0	SaC	20.00	5.60	6.54	37.5
$\bar{x}$	7.568	4.372	41.83	19.73	38.44	CL	20.311	6.623	7.823	41.45
sd	0.367	0.982	3.36	3.61	2.21		1.300	1.086	1.345	2.46
CV	4.85	22.45	8.04	18.30	5.75		6.40	16.40	17.19	5.94

Table 9. Elemental analyses of fourwing saltbush, Custer Pit, Plot 3, 1975 seeding, west exposure

Sample Percentage (dry weight)

	Ca	Mg	Na	K	Fe	Mn	Zn	Cu*	Cd*	Pb*	Co*	Cr*	Ni*	Hg*	Se*	N	P	Cl
	1.21	1.32	0.575	7.49	0.106	0.0226	0.0097	22.0						0.11	3.3	1.58	0.080	2.55
	1.30	1.25	0.422	5.30	0.073	0.0212	0.0083	19.0						0.08	2.8	2.07	0.082	2.46
	1.30	1.36	0.664	6.56	0.157	0.0219	0.0081	17.0	0.58	2.7	0.5	0.2	4.0	0.09	2.4	2.10	0.082	2.37
	1.25	1.17	0.434	4.80	0.155	0.0213	0.0077	17.0						0.08	2.2	2.05	0.083	2.66
	1.16	1.13	0.410	5.20	0.117	0.0207	0.0073	17.0						0.09	2.7	1.78	0.068	2.34
	1.07	1.04	0.404	5.53	0.125	0.0173	0.0069	15.0						0.08	1.9	2.10	0.090	2.36
	1.20	1.16	0.430	7.16	0.177	0.0211	0.0069	16.0	0.61	2.7	0.6	0.7	2.6	0.04	1.5	1.26	0.077	2.55
	1.10	1.24	0.396	7.98	0.113	0.0188	0.0068	18.0						0.08	2.2	1.99	0.075	2.76
	1.13	1.10	0.322	6.84	0.102	0.0195	0.0082	18.0						0.08	2.9	2.20	0.089	2.43
	1.16	1.20	0.428	6.30	0.111	0.0190	0.0111	21.0						0.08	2.1	2.04	0.090	2.47
	1.19	1.46	0.466	7.49	0.184	0.0173	0.0077	15.0	0.64	2.3	0.7	2.0	3.1	0.05	2.3	2.03	0.078	2.44
	1.10	1.21	0.442	5.06	0.051	0.0151	0.0057	13.0						0.06	2.4	2.18	0.095	2.40
$\bar{x}$	1.181	1.220	0.4494	6.309	0.1226	0.01965	0.00787	17.33	0.610	2.57	0.60	0.97	3.23	0.077	2.39	1.948	0.084	2.483
sd	0.076	0.117	0.0888	1.101	0.0399	0.00224	0.00142	2.53	0.030	0.23	0.10	0.93	0.71	0.019	0.48	0.277	0.0076	0.127
CV	6.44	9.59	19.76	17.45	32.54	11.40	18.04	14.60	4.92	8.95	16.67	95.88	21.98	24.68	20.08	14.22	9.05	5.11

*Percentage X 10^{-4}

Table 10. Elemental analyses of fourwing saltbush, Custer Pit, Plot 3, 1975 seeding, crest exposure

	Sample Percentage (dry weight)																
	Ca	Mg	Na	K	Fe	Mn	Zn	Cu*	Cd*	Pb*	Co*	Cr*	Ni*	Hg*	Se*	N	P	Cl
	1.23	1.26	0.326	5.74	0.182	0.0133	0.0068	13						0.10	1.6	1.90	0.100	2.40
	1.40	1.24	0.340	5.88	0.131	0.0124	0.0090	13.8						0.07	4.2	1.97	0.092	2.09
	1.36	1.25	0.328	6.19	0.193	0.0151	0.0070	13	0.82	2.5	0.9	4.0	8.6	0.07	1.4	2.01	0.092	2.11
	1.35	1.11	0.262	6.74	0.119	0.0105	0.0100	15						0.06	5.0	1.98	0.096	2.11
	1.20	1.12	0.200	5.84	0.083	0.0099	0.0099	15.6						0.07	3.5	2.33	0.153	1.83
	1.58	0.98	0.260	6.18	0.117	0.0129	0.0089	14						0.08	3.0	2.09	0.134	1.76
	1.57	1.13	0.300	6.16	0.146	0.0132	0.0084	13	0.80	2.3	1.1	3.0	3.0	0.04	3.2	2.10	0.111	1.91
	1.40	1.20	0.260	5.36	0.152	0.0130	0.0087	15.3						0.05	3.8	2.11	0.103	1.88
	1.29	1.01	0.260	5.50	0.092	0.0101	0.0091	15						0.05	2.9	2.13	0.047	1.69
	1.65	1.17	0.280	5.72	0.102	0.0181	0.0131	16						0.05	4.1	2.28	0.120	2.01
	1.28	1.12	0.230	5.84	0.097	0.0171	0.0119	14.5	0.93	2.1	1.0	3.1	2.8	0.05	11.1	2.22	0.104	2.34
	1.37	0.96	0.230	5.44	0.096	0.0207	0.0123	14						0.06	4.2	2.20	0.106	2.53
$\bar{x}$	1.365	1.129	0.2730	5.883	0.1258	0.01386	0.00959	14.35	0.850	2.30	1.00	3.37	4.80	0.063	4.00	2.110	0.1048	2.055
sd	0.173	0.103	0.0434	0.389	0.0359	0.00334	0.00198	1.05	0.070	0.20	0.10	0.55	3.29	0.017	2.47	0.131	0.0256	0.262
CV	12.67	9.12	15.90	6.61	28.54	24.10	20.65	7.32	8.24	8.70	10.00	16.32	68.54	26.98	61.75	6.21	24.43	12.75

*Percentage X 10^{-4}

Table 11. Elemental analyses of fourwing saltbush, Custer Pit, Plot 3, 1975 seeding, east exposure

	Sample Percentage (dry weight)																
	Ca	Mg	Na	K	Fe	Mn	Zn	Cu*	Cd*	Pb*	Co*	Cr*	Ni*	Hg*	Se*	N	P	Cl
	1.41	1.08	0.29	5.43	0.102	0.0153	0.0073	16						0.06	1.1	1.96	0.094	1.94
	1.48	1.08	0.34	5.96	0.103	0.0176	0.0083	18.5						0.09	0.9	2.06	0.111	2.01
	1.30	0.96	0.29	5.92	0.069	0.0161	0.0128	17	0.88	1.6	0.5	2.6	2.7	0.07	2.4	2.09	0.103	1.99
	1.20	1.09	0.31	5.66	0.076	0.0124	0.0085	14						0.07	3.2	1.91	0.077	2.28
	1.18	0.97	0.26	4.98	0.061	0.0098	0.0099	14						0.08	1.9	1.91	0.091	1.80
	1.24	1.05	0.210	5.86	0.048	0.0122	0.0096	15						0.14	1.5	2.09	0.100	2.09
	1.51	1.13	0.358	6.21	0.097	0.0168	0.0084	14	*0.86	1.8	0.1	1.5	2.0	0.05	3.2	2.00	0.101	1.97
	1.13	0.87	0.252	4.80	0.048	0.0101	0.0104	14						0.02	5.9	2.34	0.104	1.95
	1.25	0.97	0.227	4.56	0.065	0.0132	0.0114	15						0.03	3.2	2.00	0.095	2.05
	1.28	1.02	0.185	5.32	0.034	0.0113	0.0119	19						0.03	2.0	2.02	0.117	1.93
	1.35	1.11	0.234	5.49	0.040	0.0112	0.0124	18	0.89	1.2	<0.1	1.5	2.2	0.03	3.9	2.33	0.140	1.92
	1.54	1.11	0.232	6.53	0.045	0.0095	0.0112	15						0.03	6.4	2.01	0.123	1.90
$\bar{x}$	1.323	1.037	0.2657	5.560	0.0657	0.01296	0.01018	15.79	0.877	1.53	0.23	1.87	2.30	0.058	2.97	2.060	0.1047	1.986
sd	0.136	0.079	0.0528	0.584	0.0244	0.00284	0.00180	1.88	0.015	0.31	0.23	0.64	0.36	0.035	1.75	0.141	0.0164	0.119
CV	10.28	7.62	19.87	10.50	37.14	21.91	17.68	11.91	1.71	20.26	100.00	34.22	15.65	60.34	58.92	6.84	15.66	5.99

*Percentage X 10^{-4}

Table 12. Elemental analyses of fourwing saltbush, Custer Pit, Plot 3, 1975 seeding, valley exposure

Sample Percentage (dry weight)

	Ca	Mg	Na	K	Fe	Mn	Zn	Cu*	Cd*	Pb*	Co*	Cr*	Ni*	Hg*	Se*	N	P	Cl
	1.81	1.35	0.308	5.57	0.116	0.0260	0.023	17						0.13	3.8	2.19	0.145	1.77
	1.61	1.27	0.291	5.36	0.070	0.0430	0.0420	25						0.03	1.5	2.18	0.102	1.71
	1.64	1.06	0.304	5.23	0.137	0.0191	0.0159	16	1.77	1.9	0.9	1.5	4.0	0.04	0.95	2.03	0.105	1.75
	1.54	1.19	0.257	5.25	0.133	0.0157	0.0107	18						0.07	2.3	2.06	0.102	1.67
	1.38	1.03	0.296	5.36	0.081	0.0155	0.0127	13						0.03	1.9	1.93	0.111	1.50
	1.40	1.05	0.274	5.52	0.114	0.0156	0.0147	15						0.04	1.6	2.09	0.095	1.58
	1.43	1.16	0.214	5.46	0.071	0.0128	0.0099	17	0.73	1.3	0.6	1.0	1.7	0.02	1.9	2.22	0.051	1.62
	1.33	1.00	0.240	5.62	0.045	0.0188	0.0089	14						0.04	2.3	2.26	0.122	1.81
	1.38	1.02	0.246	5.68	0.074	0.0124	0.0085	13						0.04	5.2	2.05	0.104	1.88
	1.36	1.07	0.312	5.64	0.103	0.0096	0.0126	15						0.03	2.4	1.97	0.103	2.25
	1.18	0.99	0.208	5.81	0.022	0.0119	0.0134	16	0.58	1.0	0.7	1.0	2.3	0.04	2.2	1.98	0.102	1.81
	1.34	1.02	0.256	5.34	0.095	0.0108	0.0133	16						0.05	1.0	2.18	0.128	1.73
$\bar{x}$	1.450	1.101	0.2672	5.487	0.097	0.01760	0.01547	16.3	1.027	1.40	0.73	1.17	2.67	0.047	2.25	2.095	0.1058	1.757
sd	0.170	0.116	0.0360	0.183	0.029	0.00917	0.00920	3.2	0.648	0.46	0.15	0.29	1.19	0.029	1.19	0.109	0.0223	0.188
CV	11.72	10.54	13.47	3.34	29.90	52.10	59.47	19.63	63.10	32.86	20.55	24.79	44.68	61.70	52.89	5.20	21.08	10.70

*Percentage X 10^{-4}

Table 13. Growth indices (height X foliage diameter in cm) of fourwing saltbush, Custer Pit, Plot 3, 1975 seeding

	Exposures			
	West	Crest	East	Valley
	168	396	252	195
	210	156	552	112
	225	272	240	144
	168	588	195	288
	360	483	529	238
	272	360	294	182
	252	144	272	575
	221	323	529	675
	182	414	266	408
	234	187	625	648
	154	110	750	460
	84	552	672	700
$\bar{x}$	210.83	332.08	431.33	385.42
sd	68.98	161.99	196.98	220.68
CV	32.72	48.78	45.67	57.22

Table 14. Mean elemental concentrations of spoil and fourwing saltbush for the four exposures

Elements	Sample Percentage (dry weight) Spoil	Fourwing Saltbush	Biomagnification Factor (plant/spoil)
Ca	1.856	1.330	0.72
Mg	0.1030	1.1218	10.89
Na	0.0811	0.3138	3.87
K	0.0202	5.8098	287.61
Fe	0.00671	0.1028	15.32
Mn*	0.02471	0.01602	0.65
Zn*	1.475	107.8	73.09
Cu*	0.492	15.94	32.40
Cd*	0.0818	0.841	10.28
Pb*	2.258	1.95	0.86
Co*	0.5212	0.64	1.23
Cr*	0.0642	1.85	28.82
Ni*	0.4250	3.25	7.65
Hg*	0.0058	0.061	10.52
Se*	0.0225	2.90	128.89
As*	0.1170		
N	0.781	2.053	2.63
Cl	0.00825	2.070	250.91
P		0.0998	

* Percentage X 10^{-4}

Table 15. Elemental analyses of differently aged fourwing saltbush plants from different mine sites

Year of Seeding Age	Site	Sample Percentage (dry weight) Ca	Mg	Na	K	Fe	Zn*	Cu*	Mn*	Se*
1972	1	1.09	0.73	1.79	3.89	0.071	84.7	12.3	125.0	7.03
5-yr	2	1.01	0.61	2.47	4.11	0.079	91.3	11.0	94.0	1.50
	3	0.91	0.60	2.45	2.92	0.108	118.7	12.3	107.0	1.23
	4	0.74	0.71	1.42	4.12	0.106	161.7	9.7	157.7	0.67
	$\bar{x}$	0.94	0.66	2.03	3.76	0.091	114.1	11.3	120.9	2.61
	sd	0.15	0.07	0.52	0.57	0.019	35.0	1.2	27.6	2.97
	CV	15.96	10.61	26.62	15.16	20.88	30.67	10.62	22.83	113.79
1973	1	0.94	0.58	2.35	3.09	0.083	73.3	10.7	70.0	1.37
4-yr	2	0.87	0.56	4.22	2.29	0.089	79.0	10.0	121.3	0.97
	3	0.88	0.75	2.28	3.25	0.119	134.7	17.0	73.7	0.93
	4	0.87	0.80	4.64	2.80	0.113	143.7	16.0	86.3	2.13
	$\bar{x}$	0.89	0.67	3.37	2.86	0.101	107.7	13.4	87.8	1.35
	sd	0.03	0.12	1.23	0.42	0.018	36.7	3.6	23.4	0.56
	CV	3.37	17.91	36.50	14.69	17.82	34.08	26.87	26.65	41.48
1974	1	0.91	0.75	0.51	4.01	0.078	197.7	22.3	305.0	0.47
3-yr	2	0.85	0.94	0.62	3.76	0.058	278.7	34.0	228.0	0.23
	3	0.68	0.77	0.15	3.84	0.066	117.3	17.3	144.0	0.73
	4	0.60	0.85	0.12	4.32	0.053	263.7	28.7	271.0	0.43
	$\bar{x}$	0.76	0.83	0.35	3.98	0.064	214.4	25.6	237.0	0.47
	sd	0.14	0.09	0.25	0.25	0.011	73.6	7.3	69.5	0.21
	CV	18.42	10.84	71.43	6.28	17.19	34.33	28.52	29.32	44.68
1975	1	0.84	0.65	1.36	3.44	0.037	57.3	10.0	53.0	0.47
2-yr	2	0.74	0.77	0.07	3.78	0.030	93.3	23.3	309.3	0.73
	3	0.66	0.73	1.67	4.33	0.032	43.3	11.0	66.3	4.37
	4	0.93	0.87	0.11	4.89	0.033	75.3	16.7	96.0	2.20
	$\bar{x}$	0.79	0.76	0.80	4.11	0.033	67.3	15.3	131.2	1.94
	sd	0.12	0.09	0.83	0.64	0.003	21.7	6.1	120.1	1.79
	CV	15.19	11.84	103.75	15.57	9.09	32.24	39.87	91.54	92.27
1976	1	0.60	1.08	3.98	3.11	0.034	157.5	18.8	722.9	0.66
1-yr	2	0.64	0.92	4.07	3.46	0.038	134.2	17.9	322.0	0.94
	3	0.83	0.98	5.48	3.15	0.052	115.2	12.9	399.2	0.85
	4	0.58	1.05	4.02	2.94	0.042	88.0	14.0	373.0	0.30
	$\bar{x}$	0.66	1.01	4.39	3.17	0.042	123.8	15.9	454.3	0.69
	sd	0.11	0.07	0.73	0.22	0.008	29.4	2.9	181.9	0.28
	CV	16.67	6.93	16.63	6.94	19.05	23.75	18.24	40.04	40.58
Native	1	1.63	1.11	1.72	3.88	0.053	77.9	7.0	72.9	0.73
mature	2	1.17	1.01	2.40	3.18	0.055	94.6	6.0	42.9	0.22
	3	1.10	0.75	1.11	3.61	0.053	51.5	9.0	64.0	0.35
	4	1.23	0.69	1.02	3.21	0.076	41.5	4.5	28.5	0.02
	$\bar{x}$	1.28	0.89	1.56	3.47	0.059	66.4	6.6	52.1	0.33
	sd	0.24	0.20	0.64	0.34	0.011	24.3	1.9	20.1	0.30
	CV	18.75	22.47	41.03	9.80	18.64	36.60	28.79	38.58	90.91

* Percentage X 10^{-4}

Table 16. Elemental analyses of spoil, Doby Pit, Plot 3, 1976 seeding, four exposures

Valley		Sample Percentage (dry weight) Ca	Mg	Na	K	Fe*	Zn*	Cu*	Mn*	Se*
1.		0.770	0.067	0.043	0.0145	6	0.45	<0.5	42	1.4
2.		0.637	0.057	0.036	0.0115	2.5	0.15	<0.5	36	4.2
3.		0.882	0.072	0.044	0.013	28.0	0.65	<0.5	89	1.0
4.		0.777	0.092	0.052	0.010	8.5	0.50	<0.5	47	0.7
	$\bar{x}$	0.767	0.072	0.044	0.0123	11.25	0.438		53.50	1.83
	sd	0.100	0.015	0.007	0.0019	11.43	0.210		24.09	1.61
East										
1.		0.630	0.065	0.050	0.013	11	0.85	<0.5	17	1.0
2.		0.917	0.062	0.043	0.0115	12	0.25	<0.5	64	1.7
3.		0.580	0.062	0.032	0.011	2.0	0.20	<0.5	13	<0.1
4.		0.542	0.060	0.034	0.0065	0.5	0.05	<0.5	14	1.7
	$\bar{x}$	0.667	0.062	0.040	0.0105	6.38	0.338		27.00	1.13
	sd	0.170	0.002	0.008	0.0028	5.96	0.352		24.73	0.76
Crest										
1.		0.622	0.080	0.086	0.012	6	0.30	<0.5	17	5.2
2.		1.070	0.062	0.046	0.0075	14	0.40	<0.5	28	<0.1
3.		0.862	0.065	0.048	0.0085	21	0.40	<0.5	23	<0.1
4.		0.507	0.080	0.052	0.0156	5	0.50	<0.5	38	1.0
	$\bar{x}$	0.765	0.072	0.058	0.0109	11.50	0.400		26.50	1.60
	sd	0.251	0.010	0.019	0.0037	7.51	0.082		8.89	2.44
West										
1.		0.745	0.070	0.075	0.009	1.5	0.20	<0.5	20	<0.1
2.		0.680	0.060	0.053	0.0085	4.5	0.25	<0.5	22	7.0
3.		0.462	0.057	0.049	0.007	2.5	0.05	<0.5	11	4.2
4.		0.497	0.070	0.044	0.006	3.5	0.40	<0.5	25	3.7
	$\bar{x}$	0.596	0.064	0.055	0.0076	3.00	0.225		19.50	3.75
	sd	0.138	0.007	0.014	0.0014	1.29	0.144		6.03	2.83

*Percentage X 10^{-4}

Table 17. Physical and chemical properties of spoil and number of fourwing saltbush seedlings, Doby Pit, Plot 3, 1976 seeding, four exposures

		pH (sat. paste)	pH (extract)	Electrical Conductivity E.C. 25 (mmhos/cm)	Sand (%)	Silt (%)	Clay (%)	Textural Classification	Saturation (%)	Cation Exchange Capacity (meq/100g)	S.A.R.	E.S.P.	Seedling Density (25 m^2)
Valley													
1.		7.41	7.98	4.87	54.2	14.2	31.6	SaCL	36.8	15.8	12.35	14.50	2
2.		7.17	8.07	5.58	64.5	9.3	26.2	SaCL	31.7	10.5	11.62	13.70	84
3.		7.12	8.12	5.36	58.6	12.3	29.1	SaCL	38.8	15.8	12.09	14.22	7
4.		6.56	7.98	6.30	65.4	9.2	25.4	SaCL	36.8	17.6	14.85	17.08	8
	$\bar{x}$	7.16	8.04	5.52	60.7	11.3	28.1		36.0	14.93	12.73	14.88	25.3
	sd			0.61	5.27	2.44	2.84		3.03	3.07	1.45	1.51	39.3
													CV 155.46
East													
1.		6.84	7.97	6.16	60.9	12.1	27.0	SaCL	33.8	14.8	16.07	18.33	29
2.		7.37	7.97	5.84	62.9	11.5	25.6	SaCL	34.7	13.1	11.73	13.82	23
3.		7.03	8.15	5.32	71.4	8.0	20.6	SaCL	31.3	9.2	10.65	12.62	1
4.		7.05	8.16	5.65	69.7	10.0	20.3	SaCL	31.2	10.1	11.70	13.79	12
	$\bar{x}$	7.12	8.07	5.74	66.2	10.4	23.4		32.8	11.80	12.54	14.64	16.3
	sd			0.35	5.11	1.83	3.43		1.77	2.60	2.41	2.52	12.4
													CV 76.10
Crest													
1.		6.55	8.30	7.00	56.7	14.3	29.0	SaCL	39.4	18.4	27.27	28.04	186
2.		7.00	8.00	6.16	64.1	12.5	23.4	SaCL	31.4	11.3	11.70	13.79	103
3.		6.58	8.37	5.42	59.2	12.4	28.4	SaCL	35.7	10.0	13.44	15.66	51
4.		6.22	8.25	6.98	59.9	11.7	28.4	SaCL	36.9	13.7	17.90	20.09	65
	$\bar{x}$	6.68	8.25	6.39	60.0	12.7	27.3		35.9	13.35	17.58	19.40	101.3
	sd			0.76	3.07	1.11	2.62		3.34	3.70	6.97	6.34	60.6
													CV 59.87
West													
1.		7.34	8.08	7.21	65.5	11.0	23.5	SaCL	33.3	13.7	22.25	23.99	
2.		7.07	7.74	5.62	67.6	10.0	22.4	SaCL	33.9	13.7	16.57	18.82	42
3.		6.78	8.06	6.32	70.5	8.7	20.8	SaCL	31.2	11.4	18.09	20.27	81
4.		7.18	7.96	7.00	69.6	10.0	20.4	SaCL	33.0	13.0	15.45	17.71	25
	$\bar{x}$	7.14	7.98	6.54	68.3	9.93	21.8		32.9	12.95	18.09	20.20	103
	sd			0.72	2.23	0.94	1.44		1.16	1.08	2.98	2.74	62.8
													35.6
													CV 56.78
	$\bar{x}$	7.06	8.10	6.05	63.8	11.1	25.1	SaCL	34.4	13.26	15.23	17.28	51.4
	sd			0.71	5.21	1.87	3.62		2.76	2.75	4.51	4.26	50.4

Table 18. The mean numbers per 25 m^2 plot of fourwing saltbush plants on the four exposures, Doby Pit, Plot 3, 1976 seeding

	Exposures			
Subplot No.	West	Crest	East	Valley
1	42	186	29	2
2	81	103	23	84
3	25	51	1	7
4	103	65	12	8
$\bar{x}$	62.75	101.25	16.25	25.25
sd	35.63	60.62	12.37	39.25
CV	56.78	59.87	76.10	155.46

Table 19. Physical and chemical properties of spoil, Doby Pit, Plot 3, 1976 seeding

Plot	PH (sat. paste)	pH (extract)	Electrical Conductivity E.C. 25 (mmhos/cm)	Sand (%)	Silt (%)	Clay (%)	Textural Classification	Saturation (%)	Cation Exchange Capacity (meq/100g)	S.A.R.	E.S.P.
1	7.34	8.08	7.21	65.5	11.0	23.5	SaCL	33.3	13.7	22.25	23.99
2	7.07	7.74	5.62	67.6	10.0	22.4	SaCL	33.9	13.7	16.57	18.82
3	6.78	8.06	6.32	70.5	8.7	20.8	SaCL	31.2	11.4	18.09	20.27
4	6.55	8.30	7.00	56.7	14.3	29.0	SaCL	39.4	18.4	27.27	28.04
5	7.00	8.00	6.16	64.1	12.5	23.4	SaCL	31.4	11.3	11.70	13.79
$\bar{x}$	6.95	8.04	6.46	64.88	11.30	23.82	SaCL	33.84	13.70	19.18	20.98
sd	0.30	0.20	0.65	5.17	2.18	3.09		3.32	2.88	5.89	5.38
CV	4.31	2.50	10.06	7.97	19.29	12.97		9.81	21.02	30.71	25.64

Table 20. Elemental analyses of spoil, Doby Pit, Plot 3, 1976 seeding

Plot No.	Sample Percentage (dry weight) Ca	Mg	Na	K	Fe*	Zn*	Cu*	Mn*	Se*
1	0.745	0.070	0.075	0.009	1.5	0.20	<0.5	20	<0.1
2	0.680	0.060	0.053	0.0085	4.5	0.25	<0.5	22	7.0
3	0.462	0.057	0.049	0.007	2.5	0.05	<0.5	11	4.2
4	0.622	0.080	0.086	0.012	6	0.30	<0.5	17	5.2
5	1.070	0.062	0.046	0.0075	14	0.40	<0.5	28	<0.1
$\bar{x}$	0.716	0.066	0.062	0.009	5.70	0.240	<0.5	19.6	3.32
sd	0.224	0.009	0.018	0.002	4.96	0.129		6.3	3.11
CV	31.28	13.64	29.03	22.22	87.02	53.75		32.14	93.67

* Percentage X 10^{-4}

Table 21. Characteristics of fourwing saltbush after first and second year growth as affected by competition with Russian thistle, Doby Pit, Plot 3, 1976 seeding

		1976									
		No Competition					With Competition				
	Plot No.	Plant Density (25 m^2)	Height (cm)	Diameter (cm)	Cover (%)	Growth Index	Plant Density (25 m^2)	Height (cm)	Diameter (cm)	Cover (%)	Growth Index
	1	90	10.33	14.69	3.82	152	42	8.19	6.00	1.41	49
	2	66	12.21	20.45	4.00	250	81	13.72	5.99	6.41	82
	3	27	15.81	21.81	2.57	345	25	11.80	5.72	1.29	68
	4	127	19.62	31.09	18.80	610	186	11.85	5.68	14.46	67
	5	96	9.31	11.46	3.65	107	103	13.46	6.04	7.81	81
$\bar{x}$		81.20	13.46	19.90	6.57	292.8	87.40	11.80	5.89	6.28	69.5
sd		37.29	4.24	7.54	6.86	199.7	63.17	2.21	0.17	5.43	13.5
CV		45.92	31.50	37.89	104.41	68.20	72.28	18.73	2.89	86.46	19.35
		1977									
	1	116	45.86	41.93	88.11	1923	62	30.23	25.56	21.22	772.7
	2	90	45.98	41.09	69.96	1889	56	29.45	23.36	19.98	688.0
	3	26	44.62	40.35	17.79	1800	7	15.57	13.57	0.59	211.3
	4	133	40.68	47.41	75.59	1929	49	23.06	16.61	9.38	383.0
	5	110	41.53	38.21	81.42	1587	68	25.46	20.10	16.01	511.8
$\bar{x}$		95.00	43.73	41.80	66.57	1825.6	48.40	24.75	19.84	13.44	513.3
sd		41.52	2.48	3.43	28.09	143.0	24.19	5.91	4.87	8.54	226.9
CV		43.71	5.67	8.21	42.20	7.83	49.98	23.88	24.55	63.54	44.20

Table 22. Density and foliage cover of principal plant species after discing, reseeding, and no sheepsfoot treatment in August, 1976 of a plot previously overgrown with Russian thistle, Doby Pit, Plot 3

Sample no.	Alkali sacaton + western wheatgrass		Fourwing saltbush		Russian thistle	
	Nov. 1976	Nov. 1977	Nov. 1976	Nov. 1977	Nov. 1976	Nov. 1977
1	5(25)[1]	10(50)				1(100)°[2]
2	3(5)	4(22)			3(20)	1(85)°
3	3(2)			1(70)		1(70)°
4	1(3)			1(70)	1(3)	1(30)
5		6(19)				2(10)
6	2(1)	2(40)				4(50)
7	14(12)	9(55)	1(2)		2(20)	1(90)°
8	1(12)	3(24)				1(100)°
9		1(5)		1(30)	2(17)	2(70)°
10	8(15)	5(20)		1(40)		1(60)°
11	1(8)	11(25)				
12	7(8)	3(40)				2(10)
13	5(4)	3(17)		1(100)	1(2)	
14		4(15)			1(3)	1(100)°
15					1(95)	1(80)°
16		2(20)				
17	2(3)	1(3)		2(60)	1(16)	
18	3(6)				1(1)	2(60)°
19	4(12)					1(100)°
20	6(18)	3(46)			1(24)	2(100)°
21	2(2)	1(60)				
22		1(20)		1(33)	1(13)	1(100)°
23	9(18)			1(100)	1(7)	
24	1(3)	2(9)				1(100)°
25		1(5)			3(38)	1(80)°
26	4(16)	2(40)		1(12)	3(23)	
27	4(19)				1(14)	2(90)°
28	3(11)			1(100)	3(48)	
29	2(15)			1(100)		
30	2(3)	3(20)				3(80)°
						1976 / 1977
$\bar{x}$	3.07	2.57	0.03	0.40	0.87	1.07
	(7.37)	(18.50)	(0.07)	(23.83)	(11.47)	(52.17)
sd	3.23	3.01			1.04	0.98
	(7.23)	(18.64)			(20.10)	(42.18)

Σ 1976: 3.97 (18.91); Σ 1977: 4.04 (94.50)

[1] 5 = density (ft^2); (25) = foliage cover (%)

[2] ° = Russian thistle foliar cover overlapping other species

Table 23. Density and foliage cover of principal plant species after discing, reseeding, and one sheepsfoot treatment in August 1976 of a plot previously overgrown with Russian thistle, Doby Pit, Plot 3

Sample no.	Alkali sacaton + western wheatgrass		Fourwing saltbush		Russian thistle	
	Nov. 1976	Nov. 1977	Nov. 1976	Nov. 1977	Nov. 1976	Nov. 1977
1	1(2)[1]	2(15)			4(29)	
2	4(6)	2(15)				1(40)
3	8(8)	1(7)	1(2)		3(84)	1(100)°[2]
4		5(12)			5(23)	2(100)°
5	1(3)	4(12)			4(42)	1(30)°
6		1(6)		1(100)°	3(84)	
7	1(7)			1(40)	3(37)	1(30)°
8		3(70)		1(30)	2(59)	2(100)°
9	2(14)	4(33)			3(19)	3(100)°
10	2(13)	3(11)			2(51)	1(100)°
11	3(5)				7(49)	
12	4(5)	3(21)			2(64)	
13	4(5)	3(30)			3(51)	2(100)°
14	3(9)	1(4)		1(100)°	2(19)	
15	1(2)	5(30)			5(91)	2(100)°
16	1(3)	1(10)			4(75)	1(30)
17	1(3)	3(29)		1(30)°	5(83)	2(75)°
18	4(6)			1(100)	4(86)	
19	5(16)	4(13)	1(9)	1(70)°	5(29)	4(100)°
20	8(13)	3(7)		1(20)	1(26)	
21	3(4)				3(18)	
22	1(2)	2(7)				2(70)°
23	6(7)					3(100)°
24	2(6)	1(12)		1(100)°	3(31)	
25	7(9)	2(11)			12(90)	1(100)°
26	8(8)	3(16)			1(4)	4(100)°
27	1(2)	1(40)			2(92)	3(100)°
28	1(2)			1(60)°		2(40)°
29	1(4)	2(11)			2(9)	2(100)°
30	3(15)	1(34)			2(11)	1(100)°
						1976 / 1977
$\bar{x}$	2.87	2.00	0.07	0.33	3.07	1.37 Σ 6.01 / 3.70
	(5.97)	(15.20)	(0.37)	(21.67)	(41.87)	(57.17) Σ (48.21) / (94.04)
sd	2.47	1.53			2.41	1.22
	(4.54)	(15.39)			(32.01)	(44.87)

[1] 1 = density (ft^2); (2) = foliage cover (%)

[2] ° = Russian thistle foliar cover overlapping other species

Table 24. Density and foliage cover of principal plant species after discing, reseeding, and three sheepsfoot treatments in August 1976 of a plot previously overgrown with Russian thistle, Doby Pit, Plot 3

Sample no.	Alkali sacaton + western wheatgrass		Fourwing saltbush		Russian thistle	
	Nov. 1976	Nov. 1977	Nov. 1976	Nov. 1977	Nov. 1976	Nov. 1977
1	7(10)[1]	2(28)				
2	1(3)	3(4)		1(75)	1(4)	1(10)
3	10(23)	2(11)	1(3)		6(28)	3(100)°[2]
4	4(13)				2(39)	
5	3(8)	1(10)			2(31)	1(70)°
6	2(2)	1(10)		1(30)	4(58)	
7	2(3)	2(12)		1(20)		2(100)°
8	6(13)	2(45)			1(15)	
9	1(4)	1(6)		1(100)°	1(8)	
10		4(28)			5(35)	1(100)°
11		1(5)			5(89)	2(90)°
12		2(50)			1(25)	
13	1(1)	3(9)				3(100)°
14	1(1)	3(11)			2(27)	1(100)°
15		1(20)				1(100)°
16	1(1)	3(16)		1(15)	1(3)	1(20)
17	5(5)	1(20)				1(90)°
18		1(6)				
19	1(2)	2(36)			1(3)	1(100)°
20		4(13)			3(85)	
21	1(2)	3(6)			3(88)	1(90)
22	8(10)	1(13)		1(90)°	2(34)	
23	3(5)	1(8)			5(58)	2(100)°
24	1(1)	3(42)			3(52)	
25	5(6)	2(45)			1(48)	4(75)°
26	3(6)	6(19)			4(60)	1(100)°
27	2(11)	2(11)		1(70)°		
28	5(19)				1(20)	
29	4(6)	1(2)			2(33)	1(50)°
30	1(1)	6(19)			5(58)	
						1976 / 1977
$\bar{x}$	2.60	2.13	0.03	0.23	2.03	0.90	Σ	4.66	3.26
	(5.20)	(16.83)	(0.10)	(13.33)	(30.03)	(46.50)	Σ	(35.33)	(76.66)
sd	2.63	1.48			1.85	1.06			
	(5.90)	(14.14)			(28.37)	(46.59)			

[1] 7 = density (ft^2); (10) = foliage cover (%)

[2] ° = Russian thistle foliar cover overlapping other species

Table 25. Density and foliage cover of principal plant species without discing, reseeding, or sheepsfoot treatment in August 1976 of an area overgrown with Russian thistle and adjacent to treated plots, Doby Pit, Plot 3

	Fourwing saltbush				Russian thistle				Alkali sacaton + western wheatgrass			
	West[1]		East		West		East		West		East	
Sample no.	Nov. 1976	Nov. 1977	Nov. 1976	Nov. 1977	Nov. 1976	Nov. 1977	Nov. 1976	Nov. 1977	Nov. 1976	Nov. 1977	Nov. 1976	Nov. 1977
1					(100)	(100)	(100)	(100)				
2					(100)	(100)	(100)	(100)				
3					(95)	(100)	(100)	(100)				
4					(100)	(100)	(100)	(52)				
5					(100)	(67)	(100)	(100)				
6					(88)	(100)	(100)	(100)				
7					(97)	(100)	(100)	(100)				
8		1(65)			(100)	(35)	(100)	(100)				
9	1(6)[2]				(100)•[3]	(100)	(100)	(100)				
10					(100)	(95)	(100)	(100)				
11					(85)	(100)	(100)	(100)				
12					(77)	(98)	(100)	(100)				
13					(100)	(100)	(100)	(100)				
14		1(20)			(100)	(100)•	(100)	(100)				
15					(100)	(100)	(100)	(100)				
16					(100)	(100)	(100)	(100)				
17					(84)	(100)	(100)	(100)				
18				1(100)	(100)	(100)	(100)	(100)				
19	1(12)				(100)•	(15)	(100)	(100)				
20	1(9)			1(85)	(100)•	(100)	(100)	(100)				
21	1(4)				(100)•	(100)	(100)	(100)				
22	1(7)				(87)•	(100)	(100)	(100)				
23					(100)	(100)	(100)	(100)				
24					(63)	(68)	(100)	(100)				
25		1(100)			(72)		(100)	(100)				
26					(100)	(45)	(100)	(100)				
27					(100)	(100)	(100)	(100)				
28	1(10)				(100)•	(100)	(100)	(100)				
29					(100)	(100)	(100)	(100)				
30					(100)	(100)	(100)	(100)				
$\bar{x}$	0.20	0.10	0	0.07								
	(1.60)	(6.17)	(0)	(6.17)	(94.93)	(27.43)	(100)	(98.40)				

[1]West = control west of treated plot; East = control east of treated plot

[2]1 = density (ft^2); (6) = foliage cover (%)

[3]• = Russian thistle foliar cover overlapping other species

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